Burden of non-communicable diseases in sub-Saharan Africa, 1990–2017: results from the Global Burden of Disease Study 2017

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Summary

Background Although the burden of disease in sub-Saharan Africa continues to be dominated by infectious diseases, countries in this region are undergoing a demographic transition leading to increasing prevalence of non-communicable diseases (NCDs). To inform health system responses to these changing patterns of disease, we aimed to assess changes in the burden of NCDs in sub-Saharan Africa from 1990 to 2017.

Methods We used data from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2017 to analyse the burden of NCDs in sub-Saharan Africa in terms of disability-adjusted life-years (DALYs)—with crude counts as well as all-age and age-standardised rates per 100 000 population—with 95% uncertainty intervals (UIs). We examined changes in burden between 1990 and 2017, and differences across age, sex, and regions. We also compared the observed NCD burden across countries with the expected values based on a country's Socio-demographic Index.

Findings All-age total DALYs due to NCDs increased by 67·0% between 1990 (90·6 million [95% UI 81·0–101·9]) and 2017 (151·3 million [133·4–171·8]), reflecting an increase in the proportion of total DALYs attributable to NCDs (from 18·6% [95% UI 17·1–20·4] to 29·8% [27·6–32·0] of the total burden). Although most of this increase can be explained by population growth and ageing, the age-standardised DALY rate (per 100 000 population) due to NCDs in 2017 (21 757·7 DALYs [95% UI 19 377·1–24 380·7]) was almost equivalent to that of communicable, maternal, neonatal, and nutritional diseases (26 491·6 DALYs [25 165·2–28 129·8]). Cardiovascular diseases were the second leading cause of NCD burden in 2017, resulting in 22·9 million (21·5–24·3) DALYs (15·1% of the total NCD burden), after the group of disorders categorised as other NCDs (28·8 million [25·1–33·0] DALYs, 19·1%). These categories were followed by neoplasms, mental disorders, and digestive diseases. Although crude DALY rates for all NCDs have decreased slightly across sub-Saharan Africa, age-standardised rates are on the rise in some countries (particularly those in southern sub-Saharan Africa) and for some NCDs (such as diabetes and some cancers, including breast and prostate cancer).

Interpretation NCDs in sub-Saharan Africa are posing an increasing challenge for health systems, which have to date largely focused on tackling infectious diseases and maternal, neonatal, and child deaths. To effectively address these changing needs, countries in sub-Saharan Africa require detailed epidemiological data on NCDs.

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Introduction

In sub-Saharan Africa, communicable diseases such as malaria, tuberculosis, and HIV have long been among the most prominent contributors to disease burden.[1] However, like most low-income and middle-income countries across the globe, countries in sub-Saharan Africa are undergoing a rapid epidemiological transition characterised by a shift from disease-burden profiles dominated by communicable diseases and childhood illnesses to profiles featuring an increasing predominance of chronic, non-communicable diseases (NCDs). Our understanding of the epidemiology of NCDs in sub-Saharan Africa is limited by the lack of established vital statistics systems and reliable population-level data for most countries in the region.[2] Nonetheless, research indicates growing burdens of diabetes,[3,4] chronic respiratory diseases,[5] chronic kidney disease,[6] cardiovascular diseases,[7,8] cancers,[9] and mental and substance use disorders[10,11] in numerous countries in sub-Saharan Africa. Furthermore, sub-Saharan Africa is expected to see one of the largest increases in mortality due to NCDs globally.[2] NCD risk factor surveillance in sub-Saharan Africa over the past decade indicates that most adults are exposed to at least one risk factor for NCDs, including tobacco consumption, harmful alcohol use, unhealthy diet, physical inactivity, obesity, or high blood pressure.[12]

Global recognition of the growing challenges posed by NCDs is reflected in the UN Sustainable Development Goals, which include a target to reduce premature deaths

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Research in context

Evidence before this study

We searched PubMed (Dec 12, 2018) using the terms "NCD", "noncommunicable diseases", "burden", "prevalence", "mortality", "morbidity", "Africa", and "sub-Saharan" for articles published in English. The burden of communicable, maternal, neonatal, and nutritional (CMNN) diseases continues to be very high in sub-Saharan Africa relative to other regions. Data on the prevalence of certain non-communicable diseases (NCDs) and their risk factors are increasingly being generated for some countries in sub-Saharan Africa; however, to our knowledge, a comprehensive assessment of all major NCDs across all countries in sub-Saharan Africa including estimates over a long period has not previously been published. This information is needed to allow informed health-system and policy development across sub-Saharan African regions and countries. The burden of disease in sub-Saharan Africa has been estimated by the Global Burden of Disease Study (GBD), but trends in NCDs across this super-region have not been comprehensively assessed and analysed to our knowledge. GBD 2017 became available in 2018 and is the latest in the series of GBD efforts since 1990.

Added value of this study

This study provides a comprehensive overview of the burden of NCDs in sub-Saharan Africa from 1990 to 2017, based on GBD 2017 data. GBD 2017 is the most recent peer-reviewed assessment of disease burden by age group, sex, cause, and location. The findings of this study will help countries to identify priority areas for interventions and will also serve as a baseline for analysing the effectiveness of programmes and policies over time.

Implications of all the available evidence

The findings of this study describe the burden of broad disease groups and specific diseases across sub-Saharan Africa. Although the burden due to CMNN diseases continues to dominate in sub-Saharan Africa as a whole, many NCDs are on the rise, especially as populations increase in number and age. Accordingly, the enhancement of interventions to control NCDs must happen in every country, in parallel with measures to address the burden of CMNN diseases. Current uncertainty around estimates of disease burden indicates the need for improved data in sub-Saharan Africa, and we call for reinforced efforts to strengthen health information systems.

due to major NCDs by 30% by 2030 and promote mental health and general wellbeing.[13,14] The WHO Global NCD Action Plan 2013–2020 also outlines global targets to reduce mortality due to major NCDs.[15] To achieve these targets, health systems will need to be equipped to address the changing patterns of disease burden; however, according to the NCD policy indicators outlined in the action plan, countries across sub-Saharan Africa do not have the appropriate measures in place to aid with reaching the targets. In many sub-Saharan African countries, health systems remain fragile, fragmented, under-resourced, and limited in terms of infrastructure and capacity to address the increasing burden of NCDs.[16,17] As NCDs increase in prevalence, existing barriers to treatment will become more apparent.[16,18] Determining which NCDs should be prioritised, both now and in the future, is necessary for local health service planning and ongoing global health efforts in sub-Saharan Africa.[19]

In this study, we used estimates from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2017—which uses methods that allow for the estimation of burden in countries or regions with scarce data—to provide a comprehensive and in-depth examination of the burden of NCDs in sub-Saharan Africa and to analyse the change in NCD burden from 1990 to 2017 at the regional and country levels. We aimed to investigate the role of NCDs in the epidemiological transition in sub-Saharan Africa; the burden of NCDs by cause, and how this changed between 1990 and 2017; the burden of NCDs by region, age, and sex; and the variations in NCD burden across countries according to the social, economic, and demographic variation between countries, as measured by the Socio-demographic Index (SDI).

See Online for appendix

Methods

Overview

All GBD 2017 estimates were generated and are reported here in accordance with the Guidelines for Accurate and Transparent Health Estimates Reporting (appendix p 1). The methods used by GBD 2017 are described in detail elsewhere.[20] The estimation process for NCDs in GBD 2017 is briefly summarised below.

The GBD 2017 cause list was made up of a four-level hierarchy. Causes reported within each level are mutually exclusive and collectively exhaustive (appendix p 7). Level 2 NCDs featured in GBD 2017 were cardiovascular diseases; neoplasms (cancers); chronic respiratory diseases; diabetes, urogenital, blood, and endocrine disorders; neurological disorders; cirrhosis; digestive diseases; mental disorders; substance use disorders; musculoskeletal disorders; and other non-communicable diseases (including congenital anomalies, sense organ diseases, skin and subcutaneous diseases, and oral disorders).

GBD 2017 uses the disability-adjusted life-year (DALY) to measure disease burden at the population level. DALYs are calculated by summing years of life lost (YLLs) due to premature mortality and years of life lived with disability (YLDs), thereby incorporating both fatal and non-fatal burden.[20] All estimates generated in GBD 2017 were accompanied by 95% uncertainty intervals (UIs). DALYs, YLDs, and YLLs were estimated for each NCD by sex, age (20 age groups spanning the entire lifespan), year

(six timepoints from 1990 to 2017 are presented), and location (195 countries and territories further aggregated into 21 regions and seven super-regions). Age-standardised rates were estimated on the basis of the GBD world population age standard. Sub-Saharan Africa is a super-region made up of 46 countries among four GBD regions: western sub-Saharan Africa, eastern sub-Saharan Africa, central sub-Saharan Africa, and southern sub-Saharan Africa (appendix p 18).

YLLs because of premature mortality

For direct causes of death, YLLs were calculated by multiplying the number of deaths for a given age group, sex, year, and location by the reference life expectancy. GBD 2017 estimated cause-specific deaths using data from vital registries, verbal autopsies, and other mortality surveillance databases. The International Classification of Diseases (ICD) coding system (ICD-9 and ICD-10) was used to assign each death to its direct physical cause. Deaths allocated to ambiguous or incorrect cause codes were redistributed with redistribution algorithms developed specifically for GBD purposes. For most GBD causes, death estimates were analysed with the Cause of Death Ensemble Modelling (CODEm) tool. Normative lifetables were calculated using the lowest death rates for each age group in locations with populations greater than 5 million. The reference life expectancy estimated was 86·6 years at birth and 23·8 years at 65 years. The cause of death data and model specifications are further detailed elsewhere.[1]

YLDs

For each cause, YLDs were calculated by multiplying estimates of prevalence for each age group, sex, year, and location by a corresponding disability weight. The epidemiological modelling, disability weights and comorbidity adjustments are described briefly here and in detail elsewhere.[21]

Systematic literature reviews were done to capture epidemiological data from health surveys, surveillance systems, disease registries, and hospital and claims databases. For most causes, epidemiological data were modelled with use of DisMod-MR 2.1, a Bayesian meta-regression tool designed specifically for GBD purposes. DisMod-MR 2.1 was used to estimate the prevalence of diseases, including for countries or regions that were lacking data, as well as to provide an assessment of internal consistency and UIs. Details of data input sources are available online.

Following the estimation of disease prevalence, additional steps were taken to estimate prevalent cases of each cause by severity. For some causes (eg, chronic obstructive pulmonary disease), severity was modelled via DisMod using data gathered in different locations around the world. Other causes use severity proportions from meta-analyses. For the remaining causes, individual-level survey data from the Medical Expenditure Panel Survey, the National Epidemiologic Survey on Alcohol and Related Conditions, and the 1997 Australian National Survey of Mental Health and Wellbeing were used to estimate the proportion of cases with each cause that were within each level of severity.[22] Each level of severity for each cause has an associated health state with a disability weight. These disability weights were derived from responses of more than 60 000 participants in an online internet survey and population surveys in Bangladesh, Indonesia, Peru, Tanzania, the USA, Hungary, Italy, Sweden, and the Netherlands. In the surveys, participants were presented with pairs of non-clinical descriptions of sequelae and asked which was the healthier of the two. Responses were converted into disability weights, anchored on a scale from 0 (perfect health) to 1 (death), using questions comparing the benefits of life-saving and disease-prevention programmes.[23]

The burden associated with each non-fatal sequela was first estimated independently to other sequelae; however, individuals often live with multiple sequelae at a time.

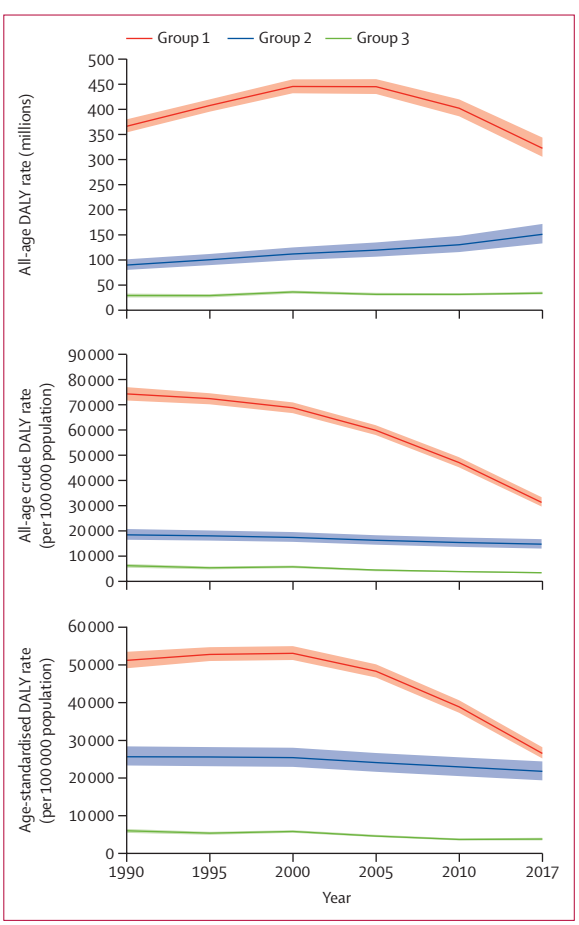

Figure 1: **Trends of cause groups 1, 2, and 3, 1990–2017**
(A) Absolute DALYs (millions). (B) All-age DALY rates (per 100 000 population). (C) Age-standardised DALY rates (per 100 000 population). Shaded regions are 95% uncertainty intervals. DALY=disability-adjusted life-year. Group 1=communicable, maternal, neonatal, and nutritional disorders. Group 2=non-communicable diseases. Group 3=injuries.

For the **GBD 2017 data input sources tool** see http://ghdx.healthdata.org/gbd-2017/data-input-sources

	Age-standardised DALYs per 100 000 population			All-age DALYs per 100 000 population			All-age total DALYs (thousands)		
	1990	2017	Percentage change, 1990–2017	1990	2017	Percentage change, 1990–2017	1990	2017	Percentage change, 1990–2017
All non-communicable diseases	**25 614·4 (23 303·2–28 364·2)**	**21 757·7 (19 377·1–24 380·7)**	**–15·1%**	**18 442·4 (16 489·4–20 742·2)**	**14 746·3 (12 998·6–16 739·2)**	**–20·0%**	**90 608·2 (81 013·2–101 907·3)**	**151 303·2 (133 370·8–171 750·7)**	**67·0%**
Neoplasms	**3211·2 (2914·5–3549·8)**	**2852·4 (2653·4–3081·6)**	**–11·2%**	**1921·6 (1695·9–2172·9)**	**1651·7 (1529·3–1784·6)**	**–14·1%**	**9441·0 (8331·8–10 675·5)**	**16 946·7 (15 691·4–18 311·1)**	**79·5%**
Lip and oral cavity cancer	47·8 (43·5–53·5)	45·6 (42·3–48·9)	–4·6%	24·7 (22·3–28·0)	23·4 (21·7–25·2)	–5·2%	121·5 (109·7–137·3)	240·4 (222·4–258·0)	97·9%
Nasopharynx cancer	25·1 (22·0–28·4)	19·8 (17·7–21·9)	–21·2%	14·9 (12·8–17·0)	11·7 (10·5–12·9)	–21·5%	73·1 (62·7–83·4)	119·9 (107·4–132·8)	64·0%
Other pharynx cancer	16·0 (13·1–18·2)	15·1 (12·7–16·8)	–6·0%	8·4 (6·9–9·5)	7·8 (6·6–8·7)	–6·4%	41·1 (33·8–46·8)	80·4 (67·8–89·5)	95·6%
Oesophageal cancer	189·4 (174·5–205·4)	154·2 (143·7–168·7)	–18·6%	92·5 (84·8–100·8)	72·5 (67·4–79·4)	–21·7%	454·6 (416·9–495·1)	743·8 (691·6–817·6)	63·6%
Stomach cancer	237·5 (218·1–255·7)	158·8 (149·1–169·2)	–33·2%	117·3 (107·0–126·9)	75·8 (71·1–80·9)	–35·4%	576·4 (525·8–623·6)	777·7 (729·5–829·8)	34·9%
Colon and rectum cancer	194·6 (165·7–243·8)	191·4 (178·0–206·8)	–1·6%	92·9 (78·1–117·2)	89·5 (83·0–97·1)	–3·7%	456·4 (383·6–575·8)	918·1 (852·0–996·5)	101·1%
Liver cancer	311·9 (240·5–576·1)	226·5 (206·7–257·6)	–27·4%	166·9 (128·1–309·6)	119·5 (108·6–136·1)	–28·4%	820·1 (629·1–1521·3)	1226·0 (1114·7–1396·2)	49·5%
Gallbladder and biliary tract cancer	31·1 (26·8–39·5)	26·8 (23·4–34·1)	–13·7%	14·2 (12·1–17·9)	11·9 (10·3–15·1)	–16·0%	69·6 (59·5–87·8)	122·0 (106·0–155·0)	75·3%
Pancreatic cancer	68·5 (62·1–76·6)	85·9 (79·3–93·1)	25·4%	32·0 (28·9–35·9)	38·9 (35·9–42·3)	21·5%	157·2 (142·2–176·6)	399·0 (368·2–433·9)	153·8%
Larynx cancer	45·0 (40·8–49·6)	34·4 (31·9–37·0)	–23·7%	22·5 (20·4–24·9)	16·8 (15·6–18·2)	–25·3%	110·7 (100·1–122·1)	172·8 (159·9–186·7)	56·1%
Tracheal, bronchus, and lung cancer	229·2 (209·8–248·9)	201·4 (187·2–216·8)	–12·1%	107·9 (98·8–117·2)	91·0 (84·4–98·2)	–15·6%	530·0 (485·3–576·0)	934·1 (865·5–1007·3)	76·2%
Malignant skin melanoma	18·8 (14·0–24·5)	18·1 (14·1–22·7)	–4·0%	10·8 (7·8–14·4)	10·5 (8·2–13·3)	–2·6%	53·0 (38·3–70·6)	107·9 (83·9–136·7)	103·5%
Non-melanoma skin cancer	21·1 (16·9–23·7)	22·3 (17·6–24·6)	5·4%	9·9 (8·1–11·1)	10·3 (8·3–11·4)	4·2%	48·4 (39·8–54·4)	105·5 (85·3–116·6)	54·1%
Breast cancer	272·9 (212·7–363·6)	298·6 (260·1–346·1)	9·4%	148·2 (114·1–198·8)	165·9 (143·8–192·5)	11·9%	728·1 (560·8–976·7)	1701·9 (1475·2–1975·1)	133·8%
Cervical cancer	416·1 (357·0–467·6)	292·7 (250·9–325·5)	–29·7%	234·1 (198·1–264·5)	166·3 (142·1–185·3)	–29·0%	1150·1 (973·3–1299·5)	1706·4 (1457·6–1901·4)	48·4%
Uterine cancer	30·9 (27·2–34·2)	27·1 (24·0–30·1)	–12·2%	15·2 (13·2–16·9)	12·8 (11·3–14·2)	–15·9%	74·5 (65·0–83·0)	130·9 (116·2–145·7)	75·7%
Ovarian cancer	51·5 (43·4–65·2)	56·6 (50·3–63·0)	9·9%	27·8 (23·2–35·7)	30·4 (26·9–33·9)	9·3%	136·8 (114·1–175·5)	312·2 (276·3–348·1)	128·3%
Prostate cancer	210·0 (156·0–244·6)	240·8 (169·1–282·4)	14·7%	80·9 (60·1–94·4)	88·0 (61·8–103·7)	8·8%	397·6 (295·2–463·7)	903·4 (633·9–1064·1)	127·2%
Testicular cancer	3·4 (2·9–3·8)	2·4 (2·2–2·8)	–28·6%	2·7 (2·3–3·1)	2·0 (1·7–2·3)	–27·3%	13·2 (11·2–15·0)	20·0 (17·9–23·4)	51·9%
Kidney cancer	23·5 (19·0–29·9)	25·5 (22·8–28·2)	8·9%	19·8 (14·0–27·8)	18·5 (16·3–20·90)	–6·7%	97·5 (68·8–136·5)	190·0 (167·2–214·1)	94·9%
Bladder cancer	52·9 (45·5–62·4)	46·8 (42·4–51·0)	–11·7%	23·4 (20·1–27·6)	19·8 (18·0–21·6)	–15·3%	114·9 (98·6–135·4)	203·2 (184·3–221·7)	76·8%
Brain and nervous system cancer	68·2 (47·7–93·0)	72·3 (57·3–83·8)	5·9%	72·5 (43·3–103·5)	69·1 (54·3–80·3)	–4·6%	356·1 (212·7–508·6)	709·4 (557·2–824·0)	99·2%
Thyroid cancer	16·3 (12·6–20·1)	13·0 (11·5–14·6)	–20·4%	9·9 (7·4–12·5)	7·7 (6·8–8·7)	–22·6%	48·7 (36·1–61·2)	78·8 (69·5–89·2)	61·7%
Mesothelioma	6·6 (4·5–9·1)	5·0 (4·2–5·7)	–23·8%	3·5 (2·4–5·0)	2·6 (2·2–3·0)	–26·1%	17·4 (11·9–24·5)	26·8 (22·6–30·9)	54·3%
Hodgkin lymphoma	53·3 (39·2–65·4)	34·6 (26·5–44·3)	–35·1%	50·0 (34·0–63·5)	32·1 (23·9–40·6)	–35·9%	245·7 (167·0–311·8)	329·1 (245·5–416·1)	34·0%

(Table continues on next page)

	Age-standardised DALYs per 100 000 population			All-age DALYs per 100 000 population			All-age total DALYs (thousands)		
	1990	2017	Percentage change, 1990–2017	1990	2017	Percentage change, 1990–2017	1990	2017	Percentage change, 1990–2017
(Continued from previous page)									
Non-Hodgkin lymphoma	144·3 (118·7–181·1)	125·6 (112·4–138·1)	−12·9%	126·4 (95·1–169·9)	101·9 (89·8–114·9)	−19·4%	621·0 (467·3–834·5)	1045·8 (921·4–1178·5)	68·4%
Multiple myeloma	31·3 (27·9–36·3)	34·0 (29·4–37·7)	8·4%	15·0 (13·3–17·4)	15·9 (13·8–17·7)	6·5%	73·5 (65·2–85·5)	163·6 (141·7–181·7)	122·5%
Leukaemia	137·7 (111·4–179·2)	128·8 (106·6–145·0)	−6·4%	135·4 (100·3–196·4)	119·1 (99·0–135·9)	−12·1%	665·2 (492·8–965·1)	1221·6 (1015·7–1394·7)	83·7%
Other malignant cancers	240·1 (201·4–288·3)	227·3 (199·9–252·3)	−5·3%	229·7 (169·4–309·4)	205·1 (178·8–233·5)	−10·7%	1128·4 (832·2–1520·2)	2104·4 (1834·9–2395·3)	86·5%
Other neoplasms	16·2 (9·7–25·3)	21·0 (13·6–29·4)	29·6%	189·4 (171·4–210·5)	198·6 (182·6–215·6)	4·8%	919·1 (831·6–1021·2)	1946·8 (1790–2113)	111·8%
Cardiovascular diseases	**6234·8 (5840·0–6623·8)**	**4728·9 (4463·4–5027·9)**	**−24·2%**	**3168·1 (2949·3–3372·2)**	**2228·1 (2096·1–2368·8)**	**−29·7%**	**15 565·2 (14 490·3–16 567·9)**	**22 860·8 (21 507·2–24 304·8)**	**46·9%**
Rheumatic heart disease	246·3 (212·1–281·1)	130·9 (112·5–152·0)	−46·9%	198·1 (167·5–229·8)	101·0 (84·4–119·8)	−49·0%	973·2 (822·8–1129·2)	1036·7 (866·3–1228·8)	6·5%
Ischaemic heart disease	2264·9 (2062·6–2471·7)	1905·0 (1761·6–2087·7)	−15·9%	1003·2 (912·5–1095·7)	823·5 (761·5–901·4)	−17·9%	4928·7 (4483·3–5383·4)	8449·7 (7813·7–9248·5)	71·4%
Stroke	2459·5 (2271·3–2642·9)	1731·2 (1611·2–1862·4)	−29·6%	1201·8 (1105·5–1302·5)	792·4 (738·8–845·4)	−34·1	5904·4 (5431·4–6399·4)	8129·9 (7579·9–8673·7)	37·7%
Hypertensive heart disease	473·7 (320·3–610·6)	364·8 (241·1–476·5)	−23·0%	215·3 (142·9–275·3)	155·7 (100·8–200·4)	−27·7%	1057·5 (701·9–1352·7)	1597·5 (1033·8–2056·3)	51·1%
Non-rheumatic valvular heart disease	36·5 (30·9–44·7)	29·5 (26·1–33·4)	−19·2%	20·2 (16·4–26·0)	15·8 (13·8–18·4)	−21·6%	99·2 (80·8–127·7)	162·2 (141·9–188·5)	38·9%
Cardiomyopathy and myocarditis	200·3 (163·9–242·4)	140·8 (123·1–158·8)	−29·7%	166·6 (131·4–201·0)	96·9 (84·5–109·0)	−41·9%	818·6 (645·5–987·3)	994·0 (867·2–1118·5)	21·4%
Atrial fibrillation and flutter	68·3 (55·7–82·5)	69·0 (56·1–82·1)	1·0%	23·2 (18·8–28·2)	22·9 (18·5–27·7)	−1·2%	113·8 (92·5–138·4)	234·8 (190·3–283·8)	106·4%
Aortic aneurysm	58·9 (44·0–74·1)	39·2 (32·4–44·9)	−33·4%	27·8 (20·9–35·8)	18·0 (14·8–20·8)	−35·4%	136·6 (102·5–175·7)	184·4 (151·5–213·1)	35·0%
Peripheral vascular disease	13·6 (8·5–20·6)	17·4 (11·1–24·2)	27·4%	5·2 (3·2–7·9)	6·4 (4·1–8·9)	21·6%	25·8 (15·9–38·9)	65·5 (41·7–91·0)	154·0%
Endocarditis	75·0 (50·7–105·8)	47·4 (38·4–57·5)	−36·8%	81·7 (56·4–117·9)	43·5 (35·1–53·5)	−46·8%	401·6 (276·9–579·4)	446·2 (359·7–548·7)	11·1%
Other cardiovascular and circulatory diseases	337·8 (262·1–477·2)	253·7 (199·9–350·2)	−24·9%	225·1 (173·2–333·5)	152·0 (120·7–214·4)	−32·5%	1105·8 (851·0–1638·7)	1559·9 (1238·4–2200·0)	41·1%
Chronic respiratory diseases	**1899·0 (1750·0–2033·4)**	**1381·4 (1263·8–1501·9)**	**−27·3%**	**1116·5 (1009·2–1219·6)**	**793·0 (707·1–884·1)**	**−29·0%**	**5485·2 (4958·3–5991·8)**	**8136·6 (7255·3–9071·6)**	**48·3%**
Chronic obstructive pulmonary disease	1127·9 (1004·8–1262·9)	882·0 (808·3–963·8)	−21·8%	534·1 (473·0–601·8)	410·5 (372·7–453·0)	−23·1%	2624·2 (2324·1–2956·6)	4212·3 (3824·2–4648·3)	60·5%
Pneumoconiosis	7·0 (5·3–9·3)	4·8 (3·9–6·7)	−30·6%	3·3 (2·5–4·4)	2·2 (1·8–3·1)	−32·0%	16·2 (12·4–21·5)	23·0 (18·6–31·8)	41·9%
Asthma	658·5 (522·8–765·2)	396·6 (328·4–475·4)	−39·8%	504·4 (408·4–595·7)	307·4 (247·9–378·3)	−39·1%	2478·4 (2006·5–2926·7)	3154·3 (2543·6–3881·6)	27·3%
Interstitial lung disease and pulmonary sarcoidosis	30·3 (18·3–43·5)	26·9 (20·6–35·2)	−11·3%	14·6 (8·5–21·0)	12·4 (9·4–16·3)	−14·9%	71·5 (41·7–103·0)	127·1 (96·0–166·9)	77·7%
Other chronic respiratory diseases	75·4 (59·2–94·0)	71·2 (61·4–81·3)	−5·6%	60·0 (45·6–76·4)	60·4 (51·4–68·6)	0·7%	294·9 (224·1–375·4)	620·0 (527·7–703·7)	110·2%
Digestive diseases	**2394·7 (2089·2–2698·4)**	**1870·6 (1562·9–2173·3)**	**−21·9%**	**1579·7 (1416·4–1774·8)**	**1223·2 (1015·6–1423·9)**	**−22·6%**	**7760·9 (6959·0–8719·9)**	**12 551·0 (10 420·8–14 609·6)**	**61·7%**
Cirrhosis and other chronic liver diseases	1284·0 (1031·1–1574·6)	897·8 (719·6–1080·3)	−30·1%	757·2 (620·6–917·5)	539·8 (432·1–650·7)	−28·7%	3720·1 (3049·1–4507·7)	997·6 (745·5–1245·2)	48·8%
Upper digestive system diseases	522·1 (428·9–635·9)	415·2 (327·1–530·3)	−20·5%	349·7 (288·8–432·5)	284·2 (220·8–366·2)	−18·7%	1718·3 (1419·1–2125·0)	2916·0 (2265·8–3757·6)	41·07%

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	Age-standardised DALYs per 100 000 population			All-age DALYs per 100 000 population			All-age total DALYs (thousands)		
	1990	2017	Percentage change, 1990–2017	1990	2017	Percentage change, 1990–2017	1990	2017	Percentage change, 1990–2017
(Continued from previous page)									
Appendicitis	63·1 (49·0–79·0)	50·3 (38·8–61·5)	−20·3%	59·6 (42·8–85·2)	43·4 (34·1–52·2)	−27·2%	292·9 (210·2–418·8)	445·4 (350·3–535·4)	52·1%
Paralytic ileus and intestinal obstruction	244·3 (198·9–288·5)	237·1 (174·1–289·6)	−2·9%	219·8 (191·3–257·9)	184·0 (136·3–219·2)	−16·3%	1079·8 (939·7–1267·0)	1887·4 (1398·7–2249·4)	74·8%
Inguinal, femoral, and abdominal hernia	52·0 (40·6–64·3)	45·6 (34·5–56·7)	−12·3%	35·7 (28·1–44·3)	30·7 (23·4–38·5)	−13·9%	175·4 (138·2–217·8)	315·4 (239·6–394·7)	79·9%
Inflammatory bowel disease	17·7 (10·9–28·3)	16·6 (13·5–20·6)	−6·2%	14·2 (6·8–29·2)	11·5 (8·6–16·0)	−18·7%	69·6 (33·4–143·5)	118·1 (88·1–164·5)	69·8%
Vascular intestinal disorders	25·2 (15·5–31·7)	25·0 (15·2–30·5)	−1·7%	16·3 (10·2–21·1)	13·2 (8·0–16·1)	−19·1%	80·1 (50·3–103·9)	135·3 (82·5–164·9)	68·9%
Gallbladder and biliary diseases	52·7 (41·2–65·2)	53·8 (40·6–68·1)	2·0%	33·4 (25·1–41·2)	32·1 (23·4–38·9)	−3·9%	164·2 (123·3–202·4)	329·4 (240·5–399·6)	100·6%
Pancreatitis	42·5 (29·6–61·9)	47·1 (33·0–66·5)	11·0%	24·8 (17·5–36·2)	28·6 (20·1–40·6)	15·3%	121·7 (85·8–177·8)	293·1 (206·0–416·3)	140·8%
Other digestive diseases	90·9 (68·1–137·0)	82·0 (56·2–119·5)	−9·8%	69·0 (51·7–96·0)	55·7 (40·2–76·5)	−19·2%	339·1 (253·8–471·8)	572·0 (412·3–784·8)	68·7%
Neurological disorders	**1744·3 (1418·8–2117·6)**	**1674·5 (1343·9–2059·6)**	**−4·0%**	**1263·7 (998·4–1582·0)**	**1199·7 (915·5–1534·5)**	**−5·1%**	**6208·7 (4905·4–7772·6)**	**12 309·9 (9393·3–15 744·9)**	**98·3%**
Alzheimer's disease and other dementias	456·7 (411·2–499·9)	450·4 (398·3–507·9)	−1·4%	127·5 (114·8–141·9)	124·4 (110·2–140·5)	−2·5%	626·6 (564·1–697·1)	1276·1 (1130·9–1441·4)	103·6%
Parkinson's disease	69·9 (59·6–84·0)	68·9 (59·2–87·2)	−1·4%	23·8 (20·2–28·3)	22·5 (19·4–28·4)	−5·4%	117·1 (99·5–139·0)	231·2 (198·6–291·4)	97·5%
Epilepsy	453·7 (355·1–580·6)	380·0 (286·4–503·6)	−16·3%	467·8 (357·2–602·2)	378·0 (283·9–498·0)	−19·2%	2298·2 (1755·1–2958·8)	3878·9 (2913·3–5109·9)	68·8%
Multiple sclerosis	5·0 (3·6–8·7)	5·1 (3·8–6·7)	0·4%	3·0 (2·2–5·3)	3·2 (2·4–4·2)	4·5%	15·0 (10·8–26·3)	32·7 (24·9–43·4)	118·3%
Motor neuron disease	1·2 (0·9–1·7)	1·1 (0·9–1·7)	−6·1%	0·8 (0·6–1·2)	0·7 (0·5–1·0)	−12·7%	3·7 (3·0–6·0)	6·8 (5·6–10·5)	69·7%
Headache disorders	688·3 (455·9–960·1)	698·3 (462·8–979·9)	1·5%	556·3 (366·2–780·7)	591·7 (389·4–831·6)	6·4%	2733·3 (1799·2–3835·7)	6071·3 (3995·5–8532·4)	55·0%
Other neurological disorders	69·5 (46·0–94·9)	70·8 (53·1–91·7)	1·8%	84·4 (47·8–118·8)	79·2 (56·9–104·4)	−6·2%	414·8 (234·9–583·6)	813·0 (583·6–1071·6)	96·0%
Mental disorders	**1552·0 (1146·9–2014·0)**	**1538·8 (1137·2–1995·6)**	**−0·8%**	**1290·2 (946·7–1682·4)**	**1321·5 (968·6–1723·6)**	**2·4%**	**6338·9 (4651·3–8265·7)**	**13 559·2 (9938·6–17 685·3)**	**113·9%**
Schizophrenia	102·5 (76·6–126·7)	105·2 (78·9–130·8)	2·6%	71·9 (53·3–89·4)	78·3 (58·5–97·6)	8·8%	353·3 (262·1–439·3)	803·1 (599·8–1001·2)	127·3%
Depressive disorders	649·7 (457·8–879·5)	636·6 (449·8–860·8)	−2·0%	470·6 (332·6–642·5)	478·5 (337·9–653·2)	1·7%	2312·2 (1633·9–3156·5)	4909·5 (3467·4–6701·8)	112·3%
Bipolar disorder	124·5 (78·0–183·0)	125·5 (78·9–184·4)	0·8%	102·8 (64·6–152·4)	108·3 (68·1–160·3)	5·4%	505·0 (317·2–748·8)	1111·5 (698·3–1645·2)	120·1%
Anxiety disorders	307·5 (218·3–408·1)	309·0 (219·9–409·8)	0·5%	272·2 (191·8–361·1)	282·6 (198·6–374·7)	3·8%	1337·2 (942·1–1774·0)	2899·8 (2038·0–3844·8)	116·9%
Eating disorders	24·9 (15·9–36·3)	27·9 (17·8–40·6)	12·1%	23·7 (14·9–34·7)	27·9 (17·8–40·9)	17·7%	116·4 (73·2–170·6)	286·1 (182·2–419·3)	145·9%
Autism spectrum disorders	64·6 (44·3–88·3)	64·7 (44·1–88·6)	0·1%	68·9 (47·0–94·5)	68·8 (46·6–94·5)	0·0%	338·4 (231·0–464·5)	706·4 (477·9–969·2)	108·7%
Attention-deficit/ hyperactivity disorder	16·1 (9·7–25·7)	16·2 (9·9–25·9)	0·5%	18·4 (11·1–29·3)	18·8 (11·6–30·1)	2·5%	90·3 (54·6–144·2)	193·4 (118·7–308·9)	114·1%
Conduct disorder	92·9 (56·4–147·4)	94·0 (56·4–149·8)	1·2%	126·7 (76·9–202·9)	129·1 (77·5–206·0)	1·9%	622·7 (377·9–996·6)	1324·7 (795·1–2114·1)	112·7%
Idiopathic developmental intellectual disability	32·8 (11·6–61·6)	22·9 (6·2–45·1)	−30·1%	37·8 (13·5–70·3)	26·2 (7·4–51·1)	−30·7%	185·7 (66·1–345·2)	268·9 (75·5–524·8)	44·8%
Other mental disorders	136·5 (90·5–188·2)	136·9 (90·5–136·9)	0·3%	97·2 (64·2–134·5)	102·9 (68·2–142·2)	5·8%	477·7 (315·5–661·0)	1056·0 (699·8–1458·8)	121·1%

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	Age-standardised DALYs per 100 000 population			All-age DALYs per 100 000 population			All-age total DALYs (thousands)		
	1990	2017	Percentage change, 1990–2017	1990	2017	Percentage change, 1990–2017	1990	2017	Percentage change, 1990–2017
(Continued from previous page)									
Substance use disorders	**409·8 (326·4–499·0)**	**389·0 (304·6–479·1)**	**–5·1%**	**318·3 (250·0–394·7)**	**315·1 (241·9–393·7)**	**–1·0%**	**1563·6 (1228·2–1938·9)**	**3232·7 (2481·6–4039·3)**	**51·6%**
Alcohol use disorders	198·1 (152·7–254·2)	186·9 (144·8–236·4)	–5·7%	141·7 (107·1–185·5)	142·3 (107·6–184·6)	0·4%	696·4 (526·3–911·4)	1460·3 (1104·3–1893·8)	109·7%
Drug use disorders	211·7 (163·7–263·1)	202·1 (153·4–254·7)	–4·5%	176·5 (135·6–221·8)	172·7 (128·5–219·9)	–2·1%	867·2 (666·1–1089·8)	1772·3 (1318·9–2256·5)	104·4%
Diabetes and kidney diseases	**1973·9 (1784·0–2182·9)**	**1884·7 (1662·0–2127·1)**	**–4·5%**	**1160·2 (1044·5–1281·8)**	**1017·5 (894·5–1157·3)**	**–12·3%**	**5700·0 (5131·9–6297·4)**	**10 439·6 (9177·9–11 874·6)**	**83·1%**
Diabetes mellitus	1127·9 (988·8–1298·3)	1249·2 (1062·1–1458·4)	10·7%	574·6 (499·9–668·9)	623·0 (520·9–737·3)	8·4%	2823·1 (2455·9–3286·2)	6392·3 (5344·2–7564·6)	126·4%
Chronic kidney disease	837·4 (764·0–909·7)	623·3 (584·3–686·2)	–24·5%	575·9 (518·6–628·7)	391·5 (360·6–424·9)	–32·0%	2829·5 (2547·8–3088·6)	4016·7 (3699·8–4359·3)	42·0%
Acute glomerulonephritis	8·5 (4·2–12·8)	3·2 (2·1–4·9)	–62·1%	9·7 (3·9·15·1)	3·0 (1·7–4·2)	–69·2%	47·5 (19·2–74·0)	30·6 (17·9–43·4)	–35·6%
Skin and subcutaneous diseases	**612·0 (417·3–901·0)**	**607·8 (416·6–885·7)**	**–0·7%**	**658·3 (441·1–966·8)**	**630·8 (421·9–915·6)**	**–4·2%**	**3234·2 (2167·0–4749·8)**	**6472·7 (4329·3–9394·0)**	**100·1%**
Dermatitis	166·6 (94·2–267·4)	164·4 (92·9–264·1)	–1·3%	200·7 (110·6–327·1)	193·6 (107·2–315·4)	–3·5%	986·1 (543·6–1606·9)	1986·6 (1099·7–3235·8)	50·4%
Psoriasis	46·8 (33·0–61·6)	49·4 (34·7–64·9)	5·7%	36·2 (25·5–47·8)	39·4 (27·6–51·8)	7·9%	178·0 (125·4–234·7)	403·8 (283·6–531·3)	55·9%
Bacterial skin diseases	58·0 (39·4–94·9)	63·2 (46·3–105·5)	8·9%	55·2 (33·6–93·5)	51·3 (38·1–87·9)	–7·4%	270·9 (165·1–459·4)	526·8 (390·6–901·8)	48·6%
Scabies	54·1 (30·1–87·8)	52·3 (28·9–84·9)	–3·4%	60·6 (33·1–98·0)	58·5 (31·9–95·7)	–3·5%	297·8 (162·5–481·4)	600·6 (327·7–981·6)	50·4%
Fungal skin diseases	99·1 (39·4–206·8)	83·8 (33·3–172·9)	–15·4%	100·4 (39·2–210·2)	77·7 (30·3–161·6)	–29·2	493·3 (192·8–1032·8)	797·1 (310·7–1658·1)	38·1%
Viral skin diseases	49·1 (31·8–72·8)	49·1 (31·7–72·6)	–0·1%	67·9 (43·7–100·6)	65·7 (42·2–97·4)	–3·3%	333·6 (214·8–494·5)	674·5 (432·5–999·7)	50·5%
Acne vulgaris	17·3 (10·2–28·1)	23·3 (13·7–37·6)	34·7%	19·5 (11·5–31·8)	27·5 (16·1–44·7)	28·9%	95·8 (56·3–156·2)	281·6 (165·5–458·6)	66·0%
Alopecia areata	5·7 (3·7–8·4)	5·8 (3·7–8·5)	0·6%	4·9 (3·2–7·2)	5·1 (3·3–7·6)	4·5%	24·1 (15·5–35·5)	52·8 (33·6–78·3)	54·3%
Pruritus	9·0 (4·2–17·0)	9·2 (4·3–17·4)	2·0%	7·3 (3·4–13·9)	7·6 (3·6–14·3)	3·2%	36·1 (16·8–68·1)	77·8 (36·6–147·2)	53·7%
Urticaria	65·2 (43·1–91·4)	65·5 (43·5–92·2)	0·6%	77·5 (50·7–110·7)	75·9 (49·8–108·6)	–2·2%	380·8 (248·8–543·8)	778·5 (511·4–1114·6)	51·1%
Decubitus ulcer	9·9 (6·3–13·7)	9·2 (6·3–13·7)	–6·5%	4·6 (3·1–6·6)	4·2 (2·9–6·1)	–10·4%	22·8 (15·2–32·3)	43·1 (30·0–63·0)	47·1%
Other skin and subcutaneous diseases	31·3 (15·6–55·6)	32·6 (16·2–58·4)	4·3%	23·4 (11·8–41·4)	24·3 (12·1–43·6)	3·8%	114·9 (57·8–203·5)	249·5 (124·4–447·3)	53·9%
Sense organ diseases	**1093·6 (760·5–1521·7)**	**1057·8 (731·9–1472·4)**	**–3·3%**	**617·2 (425·0–871·3)**	**603·2 (410·9–855·1)**	**–2·3%**	**3032·2 (2088·0–4280·7)**	**6188·8 (4216·3–8773·3)**	**104·1%**
Blindness and vision impairment	557·5 (385·2–792·0)	525·0 (359·0–751·4)	–5·8%	302·0 (204·8–444·8)	287·0 (193·3–424·2)	–5·2%	1483·8 (1005·9–2185·1)	2944·9 (4352·0–2944·9)	49·6%
Age-related and other hearing loss	507·0 (357·1–696·0)	502·9 (351·8–693·4)	–0·8%	296·4 (208·0–411·2)	297·0 (207·6–413·8)	0·2%	1456·3 (1021·7–2020·0)	3046·9 (2130·5–4246·1)	52·2%
Other sense organ diseases	29·1 (18·2–42·0)	29·9 (18·6–43·7)	2·8%	18·8 (11·7–27·2)	19·2 (11·8–28·3)	2·3%	92·2 (57·7–133·7)	197·0 (121·5–290·8)	53·2%
Musculoskeletal disorders	**1442·4 (1069·9–1907·0)**	**1478·9 (1094·3–1970·2)**	**2·5%**	**891·5 (658·3–1179·6)**	**951·6 (697·8–1266·1)**	**6·7%**	**4380·1 (3234·4–5795·3)**	**9763·4 (7160·2–12 991·0)**	**122·9%**
Rheumatoid arthritis	46·1 (36·8–57·1)	37·9 (29·9–46·9)	–17·7%	24·8 (19·4–31·0)	20·1 (15·6–25·2)	–19·1%	121·9 (95·4–152·2)	206·0 (159·8–258·4)	69·0%
Osteoarthritis	78·5 (39·5–153·2)	84·8 (42·7–167·2)	8·1%	35·8 (17·9–70·7)	38·7 (19·4–77·0)	8·0%	176·1 (88·2–347·5)	397·2 (199·3–790·2)	125·6%
Low back pain	846·4 (604·6–1128·8)	878·2 (627·0–1179·5)	3·8%	543·1 (389·6–735·8)	590·1 (422·7–801·3)	8·7%	2668·3 (1914·1–3614·8)	6054·9 (4336·6–8221·6)	126·9%

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	Age-standardised DALYs per 100 000 population			All-age DALYs per 100 000 population			All-age total DALYs (thousands)		
	1990	2017	Percentage change, 1990–2017	1990	2017	Percentage change, 1990–2017	1990	2017	Percentage change, 1990–2017
(Continued from previous page)									
Neck pain	287·0 (201·6–402·2)	291·5 (203·3–408·7)	1·6%	169·7 (118·4–238·9)	180·3 (126·2–253·6)	−14·0%	833·5 (581·5–1173·8)	1849·6 (1294·6–2601·6)	121·9%
Gout	13·9 (9·4–19·0)	14·6 (9·9–20·0)	5·0%	6·8 (4·5–9·2)	7·2 (4·8–9·9)	6·2%	33·3 (22·2–45·4)	73·9 (49·6–101·4)	121·8%
Other musculoskeletal disorders	170·5 (118·8–229·7)	118·8 (119·7–235·4)	0·8%	111·3 (79·7–150·5)	115·2 (80·3–156·4)	3·4%	547·1 (391·4–739·4)	1181·8 (824·1–1605·0)	116·0%
Other non-communicable diseases	**3046·7 (2572·1–3768·4)**	**2292·8 (1962·6–2664·9)**	**−24·7%**	**4457·2 (3741·7–5689·5)**	**2811·0 (2443·3–3221·1)**	**−36·9%**	**21 898·2 (18 383·3–27 952·7)**	**28 841·8 (25 069·3–33 049·5)**	**31·7%**
Congenital anomalies	1655·8 (1401·8–2271·2)	1207·3 (1075·4–1415·7)	−27·1%	2979·4 (2516·3–4122·6)	1804·2 (1607·0–2134·2)	−39·4%	14 637·8 (12 362·9–20 254·3)	18 512·3 (16 488·0–21 897·3)	26·5%
Urinary diseases and male infertility	267·6 (235·7–304·1)	214·0 (189·0–242·1)	−20·0%	207·4 (178·9–235·8)	139·6 (125·0–156·0)	−32·7%	1019·2 (879·1–1158·6)	1432·3 (1282·8–1600·6)	40·5%
Gynaecological diseases	143·3 (100·4–198·5)	135·4 (92·9–191·6)	−5·5%	111·6 (78·9–154·5)	113·2 (79·0–158·4)	1·4%	548·5 (387·8–758·9)	1161·4 (810·9–1625·0)	111·7%
Haemoglobinopathies and haemolytic anaemias	501·3 (330·1–681·4)	332·2 (209·6–492·4)	−33·7%	597·2 (373·8–788·9)	366·6 (236·5–516·8)	−38·6%	2934·0 (1836·7–3875·8)	3761·7 (2427·1–5302·3)	28·2%
Endocrine, metabolic, blood, and immune disorders	147·9 (113·7–176·8)	126·4 (102·8–151·5)	−14·5%	138·3 (98·0–175·9)	110·3 (88·9–134·5)	−20·3%	679·5 (481·4–864·1)	1131·4 (911·6–1379·9)	66·5%
Oral disorders	179·1 (107·8–276·5)	186·0 (111·2–288·1)	3·9%	121·3 (72·0–188·1)	128·9 (76·3–201·9)	6·3%	596·1 (353·7–924·0)	1323·0 (782·9–2071·5)	121·9%

Data in parentheses are 95% uncertainty intervals. DALY=disability-adjusted life-year.

Table: **Age-standardised and all-age DALY rates and total DALYs in 1990 and 2017, and percentage change from 1990 to 2017**

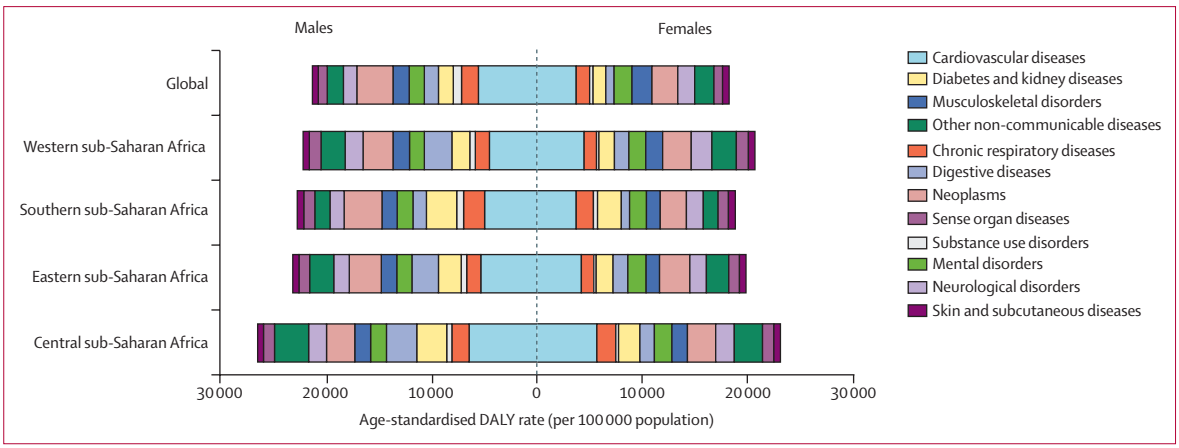

Figure 2: **Burden of non-communicable diseases globally and by sub-Saharan African region, 2017**
Data are age-standardised DALYs per 100 000 population. DALY=disability-adjusted life-year.

A microsimulation method was used to create hypothetical populations (by age, sex, year, and location) and adjust for the independent probability of experiencing more than one disease sequela. The difference in disability weights for individuals experiencing one sequela and the multiplicatively combined disability weight in those experiencing two or more sequelae was the comorbidity correction. The average comorbidity correction for each sequela was applied to the corresponding location-specific, age-specific, sex-specific, and year-specific YLD.

SDI

The SDI is a composite measure of development made up of the geometric mean of three common indicators:

income per capita, average years of schooling among people aged 15 years or older, and the total fertility rate.[20] The SDI metric was scaled to values ranging from 0 to 1, where 0 indicates the lowest income, lowest level of schooling, and highest fertility rate. Spline regressions were used to estimate the relationships between burden measures (DALYs, YLLs, and YLDs) and SDI and to estimate the expected values at each level of SDI.

Role of the funding source

The funder had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Between 1990 and 2017, the total number of DALYs due to NCDs for all ages increased rapidly in sub-Saharan Africa, from around 90·6 million (95% UI 81·0–101·9) to 151·3 million (133·4–171·8), representing a 67·0% increase (figure 1, table). Of the total burden of disease across sub-Saharan Africa from 1990 (486·0 million [469·6–503·3] DALYs) to 2017 (507·6 million [477·7–543·7] DALYs), the proportion of NCDs increased from 18·6% (95% UI 17·1–20·4) to 29·8% (27·6–32·0). Meanwhile, communicable, maternal, neonatal, and nutritional (CMNN) diseases declined, particularly from 2005 onwards, despite a notable increase in the burden of HIV/AIDS between 1995 and 2005 (figure 1). The growth in population size was the key driver of NCD burden over this period and, accounting for changes in population age-structure, the age-standardised DALY rate due to NCDs (21757·7 DALYs per 100 000 population [95% UI 19 377·1–24 380·7]) is now almost equivalent to that for CMNN diseases (26 491·6 DALYs per 100 000 population [25 165·2–28 129·8]; figure 1).

Apart from the group categorised as other NCDs, which includes congenital anomalies and accounted for around 28·8 million (25·1–33·0) DALYs (19·1% of the total NCD burden), cardiovascular diseases were the leading level 2 causes of NCD burden across sub-Saharan Africa in 2017, contributing more than 22·9 million (95% UI 21·5–24·3) DALYs, or 15·1% of the total NCD burden (table). The next most prominent level 2 causes were neoplasms (contributing 16·9 million [15·7–18·3] DALYs, 11·2%) and mental disorders (13·6 million [9·9–17·7] DALYs, 9·0%). Although uncertainties around these estimates were large, total DALYs due to mental disorders increased by 113·9% between 1990 and 2017, while DALYs associated with neoplasms increased by 79·5%. Within neoplasms, cervical and breast cancers were the leading causes of disease burden in 2017, followed by liver cancer (table). For most types of neoplasm, all-age and age-standardised DALY rates per 100 000 population declined across sub-Saharan Africa between 1990 and 2017; however, rates of several cancers (including pancreatic, prostate, and breast) increased (table).

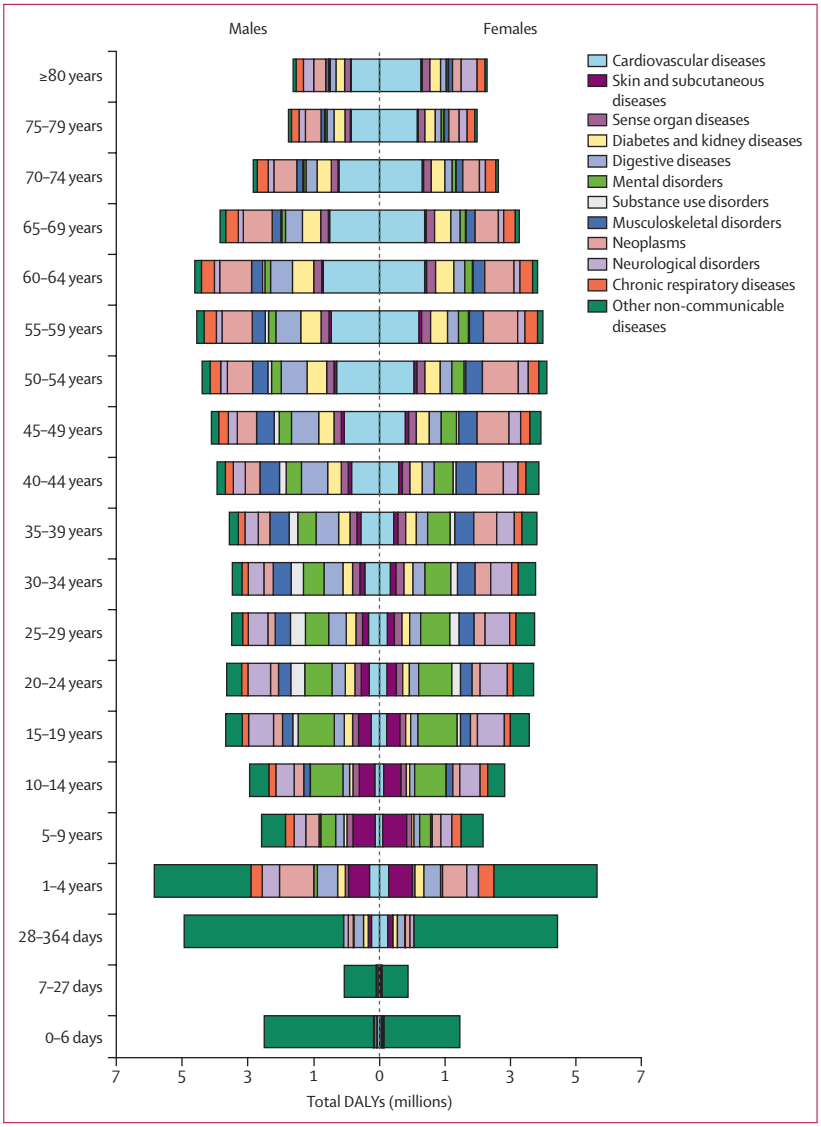

Figure 3: **DALYs for non-communicable diseases by age and sex, 2017**
DALY=disability-adjusted life-year.

Diabetes also contributes a large disease burden. Total DALYs due to diabetes increased by 126·4% between 1990 and 2017—the tenth largest change observed across all level 3 causes of NCD burden. Diabetes in sub-Saharan Africa has not only increased in terms of total DALYs, but also in terms of crude and age-standardised DALY rates, as well as YLL and YLD rates (appendix p 19).

Although the total number of DALYs due to NCDs has been increasing rapidly in sub-Saharan Africa, crude DALY rates due to NCDs overall declined by 20·0% during the 1990–2017 period, from 18 442·4 DALYs (16 489·4–20 742·2) to 14 746·3 DALYs (12 998·6–16 739·2)

per 100 000 population. The increase in total DALYs due to NCDs can be largely explained by the population growth over this period and, to a lesser extent, by population ageing (appendix p 27). Only in southern sub-Saharan Africa were changes substantially explained by an ageing population. Notably, several countries in this region, including Zimbabwe and Lesotho, have seen rapid increases in NCD burden in terms of both absolute DALYs and DALY rates, in contrast to other countries in sub-Saharan Africa, where age-standardised DALY rates have decreased (appendix p 28).

Compared with global estimates, age-standardised DALY rates by sex in each sub-Saharan African region show that sub-Saharan Africa had a high burden of NCDs overall in 2017 (figure 2). Males and females in all regions of sub-Saharan Africa had higher DALY rates for NCDs collectively compared with the global averages for both sexes. This excess burden can in part be attributed to the higher age-standardised DALY rates for cardiovascular diseases among females and diabetes and kidney diseases among males. Diabetes and kidney diseases are especially burdensome in southern sub-Saharan Africa, where the crude DALY rate (1927·2 DALYs [1693·8–2191·9] per 100 000 population) is more than double that found in other regions of sub-Saharan Africa (1233·3 [1047·6–1432·8] in central, 887·4 [771·0–1016·7] in western, and 915·2 [811·3–1029·2] in eastern sub-Saharan Africa). Ischaemic heart disease was the leading cause of cardiovascular disease burden among males (4 857 246·3 DALYs [4 417 087·3–5 429 459·4]), whereas cerebrovascular disease was most prominent among females (4 034 703·6 DALYs [3 699 338·3–4 378 417·9]).

Age-specific DALYs for NCDs by sex in 2017 show a large NCD burden throughout the life course in males and females (figure 3). The leading causes of NCD burden in children under 5 years of age were those in the other NCDs category, including congenital anomalies (9856·63 DALYs [8721·99–11 841·03] per 100 000 population) and sickle cell disorders (769·37 DALYs per 100 000 [432·88–1076·41]), while mental disorders constituted a large burden among people aged 14–39 years. The total burden of cardiovascular disease was similar between males and females.

In 2017, all-age DALY rates (per 100 000 population) varied across sub-Saharan Africa (figure 4), ranging from about 12 000 DALYs (in Ethiopia) to almost 22 000 DALYs (in Central African Republic).

The ratio of observed to expected disease burden (based on SDI) of NCDs by country in 2017 is shown in figure 4. The countries with the lowest ratios (ie, those with a lower NCD burden than would be expected on the basis of SDI) were Ethiopia, Niger, Nigeria, Uganda, and Equatorial Guinea. By contrast, age-standardised DALY rates due to NCDs in several other countries, such as Lesotho, Swaziland, Congo (Brazzaville), and Central African Republic, exceeded what would be expected of countries with a similar SDI.

Discussion

This study comprehensively describes the burden of disease caused by NCDs in sub-Saharan Africa and allows a direct comparison of NCDs over time and across countries and populations for the first time. NCDs impose a formidable burden in sub-Saharan Africa and,

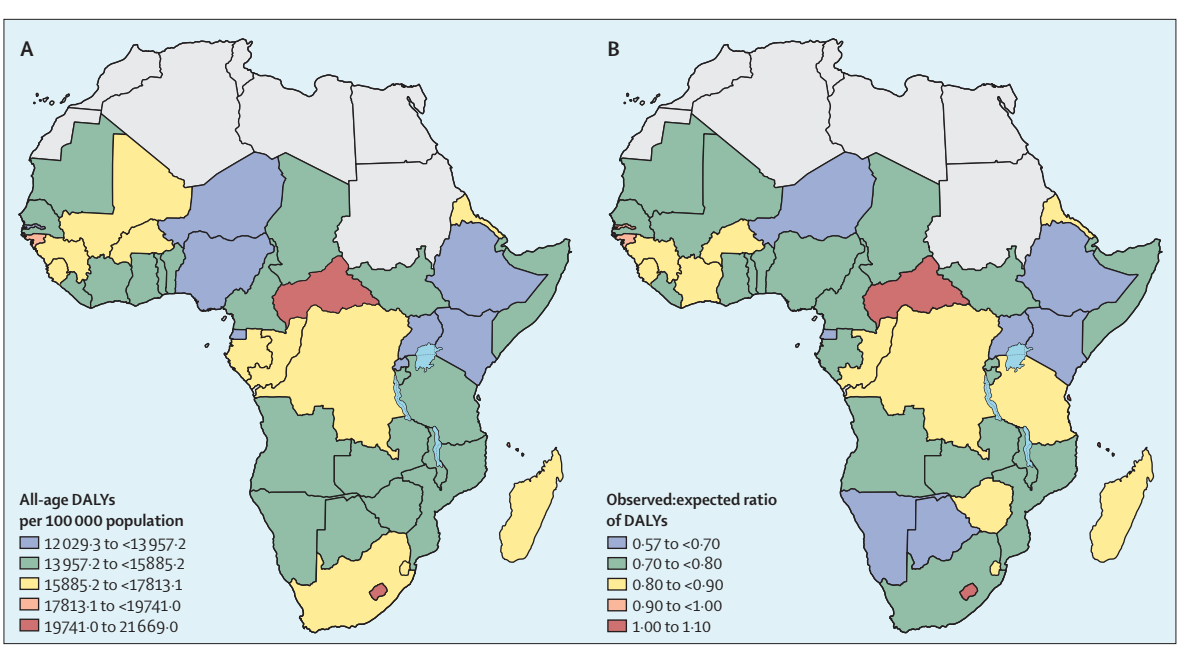

Figure 4: **Burden of non-communicable diseases by country in sub-Saharan Africa, 2017**
(A) All-age DALY rates for non-communicable diseases (per 100 000 population). (B) Ratio of observed to expected DALYs (according to the Socio-demographic Index) for all non-communicable diseases. DALY=disability-adjusted life-year.

although this increasing burden is largely due to a growing population, age-standardised DALY rates are also rapidly increasing in some countries, and YLDs are on the rise across this super-region. Furthermore, the burden of NCDs in all four sub-Saharan African regions is higher than the global average, and is now almost equivalent to the total burden associated with CMNN diseases. Thus, NCDs can no longer be neglected in sub-Saharan Africa and must be prioritised on health and development agendas. Our findings also show that a large amount of the NCD burden in sub-Saharan Africa is caused by five groups of diseases: cardiovascular diseases; mental disorders; neoplasms; diabetes; and urogenital, blood, and endocrine diseases.

There is a growing concern that cardiovascular disease burden, driven by increasing risk factors such as smoking and unhealthy diets, is likely to increase and pose challenges on health systems in sub-Saharan Africa.[7,8,24,25] The epidemiology of cardiovascular disease in these regions is unique. Historically, the burden of cardiovascular disease due to rheumatic disease arising from infectious origins has been large, while other forms of cardiovascular disease were thought to be relatively rare. Our current findings, however, indicate that strokes are a leading cause of cardiovascular disease burden, particularly among women, and this is consistent with the current literature.[26] These high rates of stroke are typically explained by high rates of hypertension and a lack of effective treatment and control in sub-Saharan Africa,[2] as well as low awareness among the population of the disease and its risk factors.[27] Furthermore, a 2018 systematic review revealed that the prevalence of dyslipidaemia (a leading contributor to cardiovascular disease) is high in Africa, affecting at least one in five adults in the region.[28]

Increasing mortality and morbidity rates from diabetes have also been reported previously.[29] Late diagnosis and poor blood-glucose control exacerbate the impact of diabetes on the sub-Saharan African population and often lead to related complications.[2] Chronic kidney disease burden (which is driven by both NCD risk factors and communicable diseases) is also likely to be high in southern sub-Saharan Africa, but efforts to understand the epidemiology of chronic kidney disease in Africa have been hampered by data quality issues.[6] The key messages of the *Lancet Diabetes & Endocrinology* Commission on Diabetes in sub-Saharan Africa are that the true burden of diabetes in sub-Saharan Africa is unknown and that more evidence on how to effectively use limited resources to screen and manage diabetes is desperately needed.[30]

Given the large treatment gaps for serious mental health conditions, such as schizophrenia, and emerging substance use epidemics, mental health and substance use disorders are predicted to lead to 45 million YLDs by the year 2050 in sub-Saharan Africa.[31] Calls to integrate evidence-based mental health services into primary health-care services,[32] as well as early interventions in the life course for mental and substance use disorders, warrant further attention. Exploring upstream prevention and health promotion strategies that address some of the social and economic risk factors—including violence, poverty, forced migration and income inequality—will be necessary to tackle this burden effectively.[33]

Our findings point to a large NCD burden during infancy and childhood due to congenital anomalies and sickle cell disorders. An estimated 50–80% of children born with sickle cell disorder die before 5 years of age, and those who survive are at heightened risk of infections and life-threatening anaemia, but are also susceptible to comorbidity with stroke, kidney disease, hypertension, and chronic lung disease.[34]

NCD burden varies across sub-Saharan African regions and age groups. Our findings show a clear urgent need to prepare health services in southern sub-Saharan Africa, which has the highest rates of diabetes, cardiovascular disease, and substance use disorders within sub-Saharan Africa.[35] Countries in southern sub-Saharan Africa, except Namibia, have the highest rates of NCDs across the entire super-region, and these rates are rising. These countries also have higher DALYs than would be expected on the basis of their SDI. The excess NCD burden observed in southern sub-Saharan Africa is likely to be associated with the rate of urbanisation and the unhealthy lifestyles associated with poverty and inequality in the area.[36,37]

NCDs in sub-Saharan Africa must be considered in regard to the epidemiological contexts of each country. First, in many sub-Saharan African countries, as CMNN diseases decrease and access to treatments such as antiretroviral therapy increases, life expectancy in sub-Saharan Africa is expected to continue rising and, therefore, the burden of NCDs is also likely to increase.[38] Second, comorbidity is likely to be an important aspect of NCD epidemiology in sub-Saharan Africa.[39] For example, antiretroviral therapy might be linked to increased cardiovascular risk,[28,40] diabetes is associated with increased risk of tuberculosis and pneumonia, and more than a third of cancer cases in Africa are associated with infectious conditions.[2] Some of the decline in cancer burden could therefore be attributed to the decrease in infectious disease epidemics.

The GBD 2017 study has some key limitations, which have been described in detail elsewhere.[20,21,41] High-quality data for causes of death remains absent across many countries in sub-Saharan Africa, and caution is needed with use of epidemiological models and the interpretation of results presented here.[29] Furthermore, in some countries in the region, the data that are available pose substantial challenges for cause-of-death analysis. For example, the analysis of all-cause mortality in countries without vital registration systems depends on the validity of sibling history data for measuring adult mortality. Although sibling history data have been shown to be

unbiased when compared with vital registration data, such comparisons are not available for sub-Saharan Africa, where sibling history data are of key importance. Without sufficient local evidence, another uncertainty arises from the reliance on evidence from high-income countries on the distribution of disease severity. These patterns could potentially reflect the effects of health care, or lack thereof. Based on an assessment of the quality of global vital registration data, only three countries in all of sub-Saharan Africa achieved a score of more than one out of five possible stars, and vital registration and verbal autopsy data were not available for 17 countries in sub-Saharan Africa.[1] Where data are available, there is substantial risk of over-interpreting verbal autopsy data, which are subject to limitations; for example, misclassification across broad categories of cause of death by verbal autopsy might be likely for causes such as cardiovascular diseases.

Large uncertainties surround the estimates of disease burden in sub-Saharan Africa, and varying data availability between countries can make comparisons difficult to interpret. Additionally, not all sources of uncertainty could be routinely captured in either the epidemiological or cause-of-death modelling processes. However, despite these limitations, this study provides the most comprehensive perspective on the burden of disease in sub-Saharan Africa to date.

NCDs are costly to health systems. The large burden of disability and the premature mortality caused by NCDs in the most productive ages of a person's life means that individuals, families, and communities suffer.[42] Many countries in sub-Saharan Africa need to invest in prevention and treatment to sustain development despite the costs of NCDs. There is growing evidence of the efficacy and cost-efficiency of integrated chronic-disease management models based on person-centred care. The rapid expansion of HIV services in sub-Saharan African countries provides learning experiences and potential models for a range of NCDs,[43,44] which could be modified for the planning and development of effective and cost-efficient NCD services. However, countries across sub-Saharan Africa vary widely in terms of social and economic development and have had a range of historical trajectories, each with their own specific health challenges and outcomes.[45] Recent advocacy efforts push for people-centred health systems that can foster home-grown initiatives to address country-specific needs.[46] NCDs continue to be severely underfunded relative to other health priorities in Africa.[47] To ensure cost-effective approaches, therefore, better understanding of the patterns of NCD burden is essential. Efforts to support the strengthening of NCD surveillance and routine data collection must be bolstered.

Contributors

HNG, FC, KS, and AJF drafted the manuscript. SA, AJF, HE, DS, JL, HNG, FC, and KS provided the analysis and helped in the interpretation of results. CL, LNA, BMM, APK, MH, TA, CSW, DJS, and HW contributed to reviewing and finalising the manuscript. DJS and HW conceptualised the study. All authors (with the exception of BMM, who died during the preparation of the paper) approved the final version of the manuscript.

Declaration of interests

We declare no competing interests.

Acknowledgments

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